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APPLICATION FOR PATENT

ON

*CONVERTER DEVICE*

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## *CONVERTER DEVICE*

### FIELD OF THE INVENTION

The present invention generally relates to the field of electronic devices, and  
5 particularly to a converter device suitable for converting circuit configurations.

### BACKGROUND OF THE INVENTION

The development of electronic systems is an involved process. For example,  
when developing new circuit boards, semiconductors and the like, different portions of an  
10 electronic system may be developed at different times. However, it is typically difficult  
if not impossible to test the system until all of the portions were completed. Therefore,  
flaws in earlier completed portions of the system may not be tested until other portions  
were completed, thereby resulting in inefficiencies and delays. Additionally, certain  
flaws and errors may not be detectable until it is possible to test the system as a whole.

15 For instance, when testing and developing a new personal computer board, a new  
integrated circuit designed for that particular board might not yet be available. However,  
even though the chip is not available, it might still be necessary to develop the board in  
advance. Therefore, developers were previously required to arrive at different board  
designs without waiting for the currently unavailable chip, which may require the  
20 designers to use less desirable chips and technologies.

Likewise, when testing and developing a new personal computer board, a new  
board designed for a particular integrated circuit may not yet be available. However,  
even though the board is not available, it might still be necessary to develop and test the  
chip in advance.

25 Therefore, it would be desirable to provide a converter device suitable for  
converting a board and/or an integrated circuit for operation with devices of different  
configurations.

### SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to a converter device. In a first aspect of the present invention, a converter device includes a board having a first side and a second side. The first side includes a first set of contacts suitable for electrically  
5 contacting an integrated circuit having a first configuration. The second side includes a second set of contacts suitable for electrically contacting a circuit board having a second configuration. The second set of contacts is communicatively coupled to the first set of contacts. Contacts having a function configured in the first configuration are not arranged with contacts having a corresponding function configured in the second  
10 configuration.

In a second aspect of the present invention, an apparatus includes an integrated circuit, a circuit board and a converter device. The integrated circuit includes a set of contacts, wherein the integrated circuit set of contacts is suitable for operation in a first configuration. The circuit board includes a set of contacts, wherein the circuit board set  
15 of contacts is suitable for operation in a second configuration. The converter device is disposed between the integrated circuit and the circuit board. The converter board includes a first set of contacts suitable for contacting the integrated circuit having the first configuration, and a second set of contacts suitable for contacting the circuit board having the second configuration. The first set of contacts is communicatively coupled to the  
20 second set of contacts. Contacts of the integrated circuit having a function configured in the first configuration are not arranged with contacts of the circuit board having a corresponding function configured in the second configuration.

In a third aspect of the present invention, an apparatus includes an integrated circuit, a circuit board and a converter device. The integrated circuit includes a set of  
25 contacts suitable for operation in a first configuration. The circuit board includes a set of contacts suitable for operation in a second configuration. A converter device is disposed between the integrated circuit and the circuit board. The converter device includes a first set of contacts suitable for contacting the integrated circuit having the first configuration and a second set of contacts suitable for contacting the circuit board having the second

configuration. The first set of contacts is electrically coupled to the second set of contacts. The integrated circuit set of contacts includes at least one contact having a function corresponding to a function of a contact of the circuit board. The integrated circuit contact is positioned so that when the integrated circuit is arranged with the circuit board, the integrated circuit contact is not positioned for electrical coupling to the contact of the circuit board having a corresponding function.

It is to be understood that both the forgoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention as claimed. The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate an embodiment of the invention and together with the general description, serve to explain the principles of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The numerous advantages of the present invention may be better understood by those skilled in the art by reference to the accompanying figures in which:

FIG. 1A is an illustration of an exemplary embodiment of the present invention wherein an integrated circuit having a first configuration is shown;

FIG. 1B is an illustration of an embodiment of the present invention is shown wherein a circuit board having a second configuration is incompatible with the first configuration of the integrated circuit shown in FIG. 1A;

FIGS. 2A and 2B are depictions of a top view and side view, respectively, of an embodiment of the present invention wherein a converter board is utilized to convert a first integrated circuit configuration to a second circuit board configuration;

FIG. 3A is an illustration of an exemplary integrated circuit having a first configuration;

FIG. 3B is an illustration of an exemplary circuit board having a second configuration incompatible with the first configuration of the integrated circuit shown in FIG. 3A;

FIGS. 3C, 3D and 3E are illustrations of exemplary converter board operable to be employed in conjunction to convert a first configuration to a second configuration taking into account routing considerations and the like;

FIG. 3F is a depiction of an exemplary embodiment of the present invention wherein a converter device including multiple converter boards operates to convert a first configuration of an integrated circuit to a second configuration of circuit board; and

FIG. 4 is an illustration of an exemplary embodiment of the present invention wherein a converter device including multiple converter boards configured as layers, a power layer, and ground layers are shown.

#### DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the presently preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings.

Referring generally now to FIGS. 1 through 4, exemplary embodiments of the present invention are shown. When developing new circuit boards, semiconductors and the like, different portions of an electronic system may be developed at different times. However, it is difficult if not impossible to test the system until all of the portions were completed. Therefore, flaws in earlier completed portions of the system may not be identified until other portions were completed, thereby resulting in inefficiencies and delays. Even though a preexisting integrated circuit, circuit board and the like may be available, the configuration of the preexisting device may be different than the device to be tested, such as an integrated circuit (IC), circuit board, and other electronic device. Thus, it may be desirable to test and utilize portions of a system with preexisting devices having different configurations by employing a converter device to convert a first configuration to a compatible configuration.

Referring now to FIGS. 1A and 1B, an embodiment of the present invention is shown wherein an integrated circuit has a first configuration that is incompatible with a circuit board having a second configuration. An integrated circuit 100 is configured as a ball grid array 102. An integrated circuit as contemplated by the present invention may

also include a computer chip, formed in a package and form factor such as to include a chip carrier, and the like without departing from the spirit and scope of the present invention. The integrated circuit 100 includes a plurality of contacts, in this instance solder balls 104, suitable for providing electrical coupling and communication with a circuit board. Contacts may provide a specific function, such as the communication of information and information of a particular type, from the integrated circuit 100 to the printed circuit board. Thus, contacts may be configured so that each contact has a specific function that is communicated through a corresponding contact on a circuit board. In this way, an integrated circuit may have a configuration depending on the arrangement of contacts and corresponding functions of the arranged contacts. For instance, a contact 106 may be configured to provide a first function in a first configuration. However, in certain instances it may be desirable to utilize the integrated circuit with a device having a second configuration, which may be incompatible with the first configuration.

For example, as shown in FIG. 1B, a circuit board 110 includes a substrate 112 having a plurality of contacts 114. The contacts 114 are suitable for providing an electrical pathway and contact with contacts 104 disposed on an integrated circuit 100 (FIG. 1A). However, the configuration of the circuit board 110 is different from the integrated circuit 100. For example, a contact 106 (FIG. 1A) having a first function may not be arranged with a corresponding contact 116 having the first function of the circuit board 110. For instance, such as if the integrated circuit was arranged directly on a circuit board so that the corresponding functions did not align. Thus, contacts of the first configuration are out of position with contacts of a second configuration of the circuit board, making the circuit board and integrated circuit incompatible as configured.

Referring generally now to FIGS. 2A and 2B, an embodiment of the present invention is shown wherein a converter device is utilized to convert a first integrated circuit configuration to a second circuit board configuration. A converter device 200 may be provided to convert a first configuration to a second configuration. The converter device 200 includes a board 202 having a first side and a second side. The first side of

the converter board includes a first contact 206 suitable for electrically contacting a contact 106 of an integrated circuit 100. The second side of the converter board 200 includes a second contact 216 suitable for electrically connecting with a contact 216 of the circuit board 110.

5           The first contact 206 is electrically coupled to the second contact 216, thereby creating an electrical pathway from the integrated circuit contact 106, to the first contact 206 of the converter board 200, along the electrical connection 204 to the second contact of the converter board 200, the second contact 216 disposed to make an electrical connection with a contact 116 of the circuit board 110. Thus, the converter board 200 is  
10       disposed between the integrated circuit 100 and the circuit board 110, thereby enabling a first device in a first configuration to electrically couple with a second device in a second configuration, the second configuration incompatible with the first configuration.

Referring generally now to FIGS. 3A through 3F, an embodiment of the present invention is shown wherein multiple converter boards are utilized to convert a first circuit  
15       configuration to a second circuit configuration, the first configuration unsuitable for direct connection and operation with the second configuration. A configuration board may utilize multiple signal layers to convert a first configuration to a second configuration. For example, the optimization of trace width and separation distances may warrant multiple layers to promote signal integrity. Additionally, it should be realized  
20       that a converter board and electrical connections, such as connection 204 (FIGS. 2A & 2B) may extend beyond the boundaries of an integrated circuit, contact area of a circuit board, and the like as required by routing considerations.

An integrated circuit 300 configured as a ball grid array 302 includes a plurality of contacts, in this instance solder balls 304, suitable for providing electrical coupling and  
25       communication with a circuit board. A contact 306 is included with the integrated circuit 300 that provides a first function. However, as shown in FIG. 3B, a circuit board 310 including a substrate 312 has a plurality of contacts 114 of which, a contact 306 having a function corresponding to the first function of the integrated circuit contact 306 is unreachable by the integrated circuit contact 306. Thus, the configuration of the

integrated circuit 300 is incompatible with the configuration of the circuit board 310. For example, contacts of the first configuration may be out of position with contacts of the second configuration of the circuit board. However, due to routing consideration, it may be undesirable or impractical to utilize a single converter board for converting the first configuration to a second configuration. Thus, multiple configuration boards may be utilized to perform the desired conversion.

For example, as shown in FIG. 3C, a first converter board 320 may be utilized to provide a first contact 324 positioned for electrically contacting an electrical contact 306 of the integrated circuit 300. A second contact 326 is also provided as an intermediate contact for electrically connecting to a second converter board 330, as shown in FIG. 3D. The second contact 326 is communicatively coupled to the first contact 324 over an electrical connection 328.

Likewise, the second converter board 330 includes a third contact 334 positioned for contacting the second contact 326 of the first converter board 320. A fourth contact 336 is electrically connected to the third contact 334 over an electrical connection 338. The fourth contact 336 is positioned in an intermediate position, due to routing considerations and the like, for contacting a third converter board 340. The third converter board 340 includes a fifth contact 344 arranged for contacting the fourth contact 336 of the second converter board 330. The fifth contact 344 is electrically connected 348 to a sixth contact 346, which is disposed on the third converter board 340 to contact the circuit board contact 316 (FIG. 3B). Thus, a device having a first configuration which is unsuitable for direct contact and operation with a device having a second configuration may be converted for operation, such as for testing and the like, with optimized routing.

Additionally, a converter device may include a power layer, ground layer, and dielectric layers of differing dimensions without departing from the spirit and scope of the present invention, an example of which is shown in FIG. 4. Further, it should be apparent that a converter board may also be configured as a layer of a converter device as shown in FIG. 4.



It is believed that the converter of the present invention and many of its attendant advantages will be understood by the forgoing description. It is also believed that it will be apparent that various changes may be made in the form, construction and arrangement of the components thereof without departing from the scope and spirit of the invention or  
5 without sacrificing all of its material advantages. The form herein before described being merely an explanatory embodiment thereof. It is the intention of the following claims to encompass and include such changes.

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